The claims defining the invention are as follows:

1. A method of forming a bioactive coating on a biomedical implant, the method including the step of contacting at least part of the surface of the implant prior to implantation with a plasma gas containing a reactive hydroxylating oxidant species.

2. A method as in claim 1, wherein the reactive hydroxylating oxidant species that is included in the plasma gas is formed using an agent selected from the list consisting of hydrogen peroxide, water, oxygen/water and air/water.

3. A method as in claim 2, wherein the agent that is used to form the reactive hydroxylating oxidant species in the plasma gas is hydrogen peroxide.

4. A method as in claim 1, wherein the implant is a metallic biomedical implant.

5. A method as in claim 4, wherein the implant is made from stainless steel, titanium, titanium alloy, or cobalt-chromium.

6. A method as in claim 5, wherein the implant is made from stainless steel.

7. A method as in claim 1, wherein the step of contacting the surface of the implant prior to implantation with a plasma gas containing a reactive hydroxylating oxidant species is preceded by a step of exposing the implant to an organosilane or organosilicate species to form a silica coating on at least part of the implant prior to contact with the oxidant species.

8. A method as in claim 7, wherein the step of exposing the implant to an organosilane or organosilicate species includes exposing the implant to a plasma gas formed from the organosilane or organosilicate.

9. A method as in claim 8, wherein the plasma gas also contains air or oxygen.

10. A method as in claim 9, wherein the organosilane is a tetralkylorganosilane containing alkyl groups having between 1 and 10 carbon atoms.

11. A method as in claim 10, wherein the organosilane is a tetralkylorganosilane containing alkyl groups having between 1 and 5 carbon atoms.

12. A method as in claim 11, wherein the organosilane is tetraethoxysilane.

13. A method as in claim 9, wherein the ratio of organosilane or organosilicate to air or oxygen is varied over time to deposit a graded composite silica coating.

14. A method as in claim 13, wherein the coating is a Type II silica coating.

15. A method as in claim 14, wherein the reactive hydroxylating oxidant species that is included in the plasma gas is formed using an agent selected from the list consisting of hydrogen peroxide, water, oxygen/water and air/water.

16. A method as in claim 15, wherein the agent that forms the reactive hydroxylating oxidant species that is included in the plasma gas is hydrogen peroxide.

17. A biomedical implant having a bioactive coating that is formed using the method of claim 1.

18. A biomedical implant having a bioactive coating that is formed using the method of claim 7.

19. A bioactive biomedical implant as in claim 18, wherein the implant has a hydroxylated, graded composite silica coating having an average thickness of less than 300 nm.

20. A bioactive biomedical implant as in claim 19, wherein the implant has a hydroxylated, graded composite silica coating having an average thickness of less than 200 nm.

21. A bioactive biomedical implant as in claim 20, wherein the implant has a hydroxylated, graded composite silica coating having an average thickness of less than 100 nm.

22. A method of improving the fixation of an implanted biomedical implant, the method including the step of contacting at least part of the surface of the implant prior to implantation with a plasma gas containing a reactive hydroxylating oxidant species.

23. A method as in claim 22, wherein the reactive hydroxylating oxidant species that is included in the plasma gas is formed using an agent selected from the list consisting of hydrogen peroxide, water, oxygen/water and air/water.

24. A method as in claim 23, wherein the agent that is used to form the reactive hydroxylating oxidant species in the plasma gas is hydrogen peroxide.

25. A method as in claim 22, wherein the implant is a metallic biomedical implant.

26. A method as in claim 25, wherein the implant is made from stainless steel, titanium, titanium alloy, or cobalt-chromium.

27. A method as in claim 26, wherein the implant is made from stainless steel.

28. A method as in claim 22, wherein the step of contacting the surface of the implant prior to implantation with a plasma gas containing a reactive hydroxylating oxidant species is preceded by a step of exposing the implant to an organosilane or organosilicate species to form a silica coating on at least part of the implant prior to contact with the oxidant species.

29. A method as in claim 28, wherein the step of exposing the implant to an organosilane or organosilicate species includes exposing the implant to a plasma gas formed from the organosilane or organosilicate.

30. A method as in claim 29, wherein the plasma gas also contains air or oxygen.

31. A method as in claim 30, wherein the organosilane is a tetralkylorganosilane containing alkyl groups having between 1 and 10 carbon atoms.

32. A method as in claim 31, wherein the organosilane is a tetralkylorganosilane containing alkyl groups having between 1 and 5 carbon atoms.

33. A method as in claim 32, wherein the organosilane is tetraethoxysilane.

34. A method as in claim 30, wherein the ratio of organosilane or organosilicate to air or oxygen is varied over time to deposit a graded composite silica coating.

35. A method as in claim 34, wherein the coating is a Type II silica coating.

36. A method as in claim 35, wherein the reactive hydroxylating oxidant species that is included in the plasma gas is formed using an agent selected from the list consisting of hydrogen peroxide, water, oxygen/water and air/water.

37. A method as in claim 36, wherein the agent that forms the reactive hydroxylating oxidant species that is included in the plasma gas is hydrogen peroxide.

38. A method of hydroxylating a surface of a biomedical implant, the method including the step of contacting the surface of the implant with a plasma gas formed using hydrogen peroxide.

39. A biomedical implant formed using the method of claim 38, wherein the surface concentration of hydroxyl groups on the surface of the implant is about three times the surface hydroxyl group concentration that is formed using methods other than hydrogen peroxide plasma treatment.